CHANGE ISSUE – RTCA/DO-242

MASPS for ADS-B Rev. A

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Short Title for Change Issue:	Correlation of Flight-Plan and ID

MASPS Document Reference:		Originator Information:		
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Table/Figure Number(s)		Other	Capstone	ATP-400, Manager

	Proposed Rationale for Consideration (originator should check all that apply):
	Item needed to support of near-term MASPS/MOPS development
	DO-260/ED-102 1090 MHz Link MOPS Rev A
	ASA MASPS
	TIS-B MASPS
X	UAT MOPS
	Item needed to support applications that have well defined concept of operation
	Has complete application description
	Has initial validation via operational test/evaluation
	Has supporting analysis, if candidate stressing application
	Item needed for harmonization with international requirements
X	Item identified during recent ADS-B development activities and operational evaluations
	MASPS clarifications and correction item
	Validation/modification of questioned MASPS requirement item
	Military use provision item
	New requirement item (must be associated with traffic surveillance to support ASAS)

Nature of Issue:		Editorial		Clarity	X	Performance	X	Functional

Issue Description:

The intended function of the ADS-B system for air traffic control is that the aircraft broadcasts it's position for use by air traffic control to provide surveillance services. In order to ensure the accurate tracking of aircraft transmitted ADS-B position information for surveillance purposes, a unique identification (Flight Plan ID) transmitted in the ADS-B message is required to effectively correlate the position information with the specific filed flight plan. In today's air traffic system, this is accomplished through use of the ATC assigned 4096 transponder codes.

(*Continued on next page.*)

Issue Description (*continued*):

The following are issues that are impacting the operational ADS-B system at Bethel, Alaska that have been addressed but are not resolved:

- Aircraft departing VFR from one airfield, then departing IFR from the next airfield and the auto-acquiring system tagging with the previous/wrong portion of the flight plan;
- The pilot filing IFR flight plans for one aircraft, then being assigned another by company dispatcher at departure time and there is no update of the flight plan – the filed flight plan has the wrong hexadecimal ICAO code filed and the ground automation system can't auto-acquire;
- Aircraft continually filing IFR flight plans without filing the associated hexadecimal ICAO code.

In order to resolve the above deficiencies, air traffic controllers have developed work arounds to facilitate ADS-B usage. These are not normal air traffic controller functions: controller frustrations and workload are increasing, and resolution is required.

Additional efficiencies may be realized using a Flight-Plan ID such as allowing surveillance of VFR flights for search and rescue purposes and allowing surveillance of any flight to determine intent for possible security or airspace restriction purposes.

Inclusion of Mode 3A / 4096 codes within the link MOPS:

While this issue was received after DO-242A was published, the two ADS-B link MOPS have incorporated the use of 4096 codes within their specifications.

The UAT MOPS (DO-282) added a bit labeled Call Sign Identification (CSID) in the Mode Status Element. The CSID bit can be used to indicate what information is being transmitted in the Call Sign field of the Mode Status Element. While the MOPS requires that the CSID bit be set to ONE, and that the Call Sign always be loaded into the Call Sign field, the hooks are in place for equipment to deviate from the MOPS and load the 4096 code into the Call Sign field, and indicating the 4096 code is being broadcast by setting the CSID bit to ZERO. This will likely be done by CAPSTONE II equipment which will alternate between broadcasting Call Sign and 4096 codes within every other Mode Status element transmitted. While this solution should be acceptable for Capstone and other low-density airspace, the reduction of the broadcast of Call Sign in higher density airspace needs to be examined from safety and operational perspectives. (See attachment B for DO-282 requirements.)

The 1090 MOPS (DO-260A) has coded SUBTYPE 7 of the "TEST" message (TYPE 23) to include the 4096 Code. Further specifications limit the transmission of this message to only occur over North America. This was done to satisfy ICAO concerns about sending extra broadcast messages in Europe where the presence of 4096 codes is currently obtained by Mode S interrogations and is to be phased out in the coming years. (See attachment B for DO-282 requirements.)

Originator's proposed resolution:

Accurate prediction of aircraft intent is a critical component of separation assurance. Information predicting intent is drawn from the flight plan in ground automation and by controllers viewing the situation. Establishing and maintaining a correlated, discrete link between the aircraft's target information and the flight plan during transitions between radar and ADS surveillance modes and between procedural and surveillance-based separation is essential to safe, efficient use of the airspace. Today, the air traffic control system issues discrete, changeable codes to IFR aircraft, similar to the existing Mode 3/A 4096 transponder process, to link aircraft flight plans with transmitted position information in the air traffic system. To resolve the problems described above, we propose to extend this process into the ADS-B environment in the following manner:

(*Continued on next page.*)

Originator's proposed resolution (*Continued*):

Add field to Mode Status report:

Add a Flight-Plan ID field to MASPS Identification requirements (Section 2.1.2.1). This should accommodate current Mode 3/A 4096 code, but be expandable for future US/international flight plan ID schemes in ground system automation.

A solution that is currently being reviewed for implementation in UAT Capstone II equipment by SC-186, WG-5, adds a Flight-Plan ID field with means provided that allows the pilot to input a unique Flight Plan Identification, (ATC Mode 3/A code) as assigned by air traffic control. (See UAT-WP-14-02.pdf at http://adsb.tc.faa.gov/WG5_Meetings/Meeting14.htm .) This code shall be broadcast in the same field as the aircraft Call Sign on an alternating basis. An optional bit has been provided in the MOPS in the Call Sign field to identify the information as Call Sign or the unique Flight Plan Identification code. (The UAT MOPS has hardwired this bit to indicate "Call Sign", but Capstone II equipment will deviate from the MOPS and use the bit to designate if "Call Sign" or "Flight Plan ID" is being sent.)

At the MASPS level, it will need to be determined if this approach raises any safety concerns. Simulations will be needed in all ADS-B links to examine the impact of broadcasting Call Sign and the new Flight Plan ID fields at half the Mode Status rate. Impact studies will also be needed on adding the Flight Plan ID field and requiring it be broadcast at the same rate as all other Mode Status Fields.

This new "Flight Plan ID" filed should accommodate current Mode 3/A 4096 codes; but should also be expandable for future US/international flight plan ID schemes in ground system automation as noted in the long-term portion below.

Facilitate transition towards future automation and auto-loading of Flight Plan ID:

Enhancements on the above requires that the issuance of these Flight Plan IDs be automated so that when aircraft start, the system automatically correlates and uplinks the discrete code with the correct flight plan and aircraft requesting air traffic service. In the event there is a problem with the Flight Plan ID entered by the pilot, or the aircraft 'tags' the incorrect leg/portion of a flight plan, the system should allow the controller to electronically uplink the correct information to the aircraft or permit the controller to tag the aircraft with the correct flight plan.

Eventually, the movement of aircraft within the NAS should automatically trigger most events that will support the pilot by updating pertinent weather tables, airport information or other data they'll need on the aircraft. To do this, the ground system automation needs to have the aircraft's intent and the way for that to happen is through a flight plan.

Administrative Note:

August 14, 2002: This Issue Paper is a combination of two Issue Papers submitted on the same topic by different ATC organizations within the FAA. The topic of correlating flight plans to an ID field broadcast by ADS-B was first requested in review of the UAT ADS-B MOPS by Alaska ARTCC. While specific implementations for UAT Capstone II equipment was discussed, the topic was captured at a higher level with the initial submission of this Issue Paper. Feedback was solicited from other organizations, and ATP-400 (ATC org in FAA HQ) responded. Technical contact for ATP 400 is Keith Dutch, ATP-430.1 (kieth.dutch@faa.gov or 202-267-9332). Alternate contact for the Capstone office is Carl Gleason (Carl.n-ctr.Gleason@faa.gov or 907-269-1883).

Working Group 6 Deliberations:

WG6 has not formally reviewed this Issue Paper yet. This Issue Paper was created in response to the final review and comment process on the UAT ADS-B link MOPS. The UAT MOPS was submitted to the SC-186 plenary for review in June, 2002 which was after the completion of DO-242A. WG6 will consider this Issue Paper when it reconvenes to begin considering revision B of the ADS-B MASPS.

September 23, 2002: A breakout session on this Issue paper and topic was held in conjunction with the SC-186 plenary held in Brussels Belgium. This was **not** a formal WG6 meeting. While no consensus on an overall, long-term solution could be reached, there was agreement among most on the following:

- There is a real need for improved dialogue among ATC representative and SC-186 to best resolve this an other issues. Such input from ATC would ensure that ADS-B was designed to be of maximum benefit to ATC and future ATC systems would be designed to make maximum use of transmitted ADS-B data;
- Analysis would be needed to examine safety and acquisition performance of cutting the rate of call sign to half that of other Mode Status elements would be adopted at the MASPS level as will be done for Capstone II equipment;
- It would be hard to add the 4096 code as a new field within Mode Status since all links are approaching their limits in available message bits;
- This might not be an ADS-B issue, but rather an ATC automation issue, since the current ADS-B data set apparently provides sufficient information to perform the correlation of ADS-B targets and their filed flight plans.

Other thoughts on this issue raised at this breakout session included the following:

- Any final solution should not be based on 4096 codes because they will be phased out in the next 10 years or so.
- It would be difficult to implement a solution using the eight character of call sign because a eight are used by some.

Dispatcher/Operator	Pilot	Controller	ATC Computer
(1) File Flight Plan(s)			
			(2) Generate CID, ACID[1], BCN[2] On Strip in Radar
	(3) Start Avionics, Loads ACID (4) Request Clearance		
		(5) Finds Flight Plan, Issues Clearance To include BCN	
	(6) Reads Back Clearance (i.e. Routes, Altitude, BCN)		
	(7) Loads BCN		
	(8) ADS-B Running		
			(9) GBT Network Sees Aircraft, Radar Display @ Appropriate Positions (i.e. Ground Control)
	(10) Aircraft Taxis (11) Aircraft Ready For T/O		
		(12) Clears Aircraft For T/O	
	(13) Turns BCN Transponder ON		
			(14) Radar Sees 24-bit ID And If In Radar Coverage BCN
			(15) S/W Correlates ID To Flight Plan - Tags Target
		(16) Controller Observes Target, Applies Radar Rules	
	(17) Pilot Uses CDTI To Observe Other Traffic, Complies with Air-to-Air Separation Instructions		

[1] ACID = Aircraft ID
[2] BCN = Mode 3A 4096 Transponder Beacon Code

2.2.4.5.4 MODE STATUS Element

Format for the MODE STATUS element is defined in Table 2-39. This encoding **shall** apply to ADS-B Messages with PAYLOAD TYPE CODES of "1" and "3." Each of the fields shown is defined in the following subparagraphs.

Table 2-39: Format of MODE STATUS Element

Payload Byte #	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
. . .								
18	(MSB)	**Emitter Category and Call Sign Characters#1 and #2** (Base-40 encoding)						
19								(LSB)
20	(MSB)	**Call Sign Characters #3, #4, and #5** (Base-40 Encoding)						
21								(LSB)
22	(MSB)	**Call Sign Characters #6, #7, and #8** (Base 40 Encoding)						
23								(LSB)
24	**Emergency/Priority Status**			**UAT MOPS Version**			**SIL**	
25	(MSB)	**Transmit MSO**				(LSB)	**Reserved**	
26	**NACp**				**NACv**			**NIC_{BARO}**
27	**Capability Codes**		**Operational Modes**			**True/Mag**	**CSID**	
28	**Reserved**							
29								

Note: *In the above table, where MSB and LSB are not specifically noted, the MSB is the leftmost bit and the LSB is the rightmost bit.*

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2.2.4.5.4.2 "CALL SIGN" Field

The "CALL SIGN" field consists of eight characters, which must contain only decimal digits 0-9, the capital letters A-Z, and – as trailing pad characters only – the "space" character. The 37 possible different characters are represented as Base-40 digits in the range from 0 to 36. Each character of the "CALL SIGN" field **shall** be encoded as shown in Table 2-41. The left-most character of the Call Sign corresponds to Character #1; the right-most corresponds to Character #8.

If the Call Sign is not available, then all eight characters of the "CALL SIGN" Field **shall** be set to the Base-40 digit code 37.

The 8 characters of the "CALL SIGN" field **shall** be encoded with an identifier appropriate for the Emitter Category, operating rules, and procedures under which the A/V is operating. For aircraft, the "Call Sign" could be an abbreviation of the authorized radiotelephone Call Sign for that aircraft as assigned by ATS, the aircraft registration marking, or other authorized identifier for special operations.

Note: *A Call Sign of less than 8 characters should be padded with spaces in the right-most (trailing) positions. The first character should not be a space.*

Table 2-41: "Call Sign" Character Encoding

Base-40 Digit (decimal)	Character	Base-40 Digit (decimal)	Character
0	0	20	K
1	1	21	L
2	2	22	M
3	3	23	N
4	4	24	O
5	5	25	P
6	6	26	Q
7	7	27	R
8	8	28	S
9	9	29	T
10	A	30	U
11	B	31	V
12	C	32	W
13	D	33	X
14	E	34	Y
15	F	35	Z
16	G	36	SPACE
17	H	37	Not Available
18	I	38	(reserved)
19	J	39	(reserved)

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2.2.4.5.4.15 Call Sign Identification (CSID)

The Call Sign Identification (CSID) Flag in the Mode Status Element is a one-bit field (bit 7 of byte 27) which **shall** be set to ONE (1) in this version of the MOPS.

2.2.5.1.52 Mode A (4096) Code

The ADS-B Transmitting Subsystem **shall** accept the own vehicle Mode A (4096) Code from the transponder function and use such data to establish the Mode A Code subfield transmitted in the ADS-B "TEST" Message with SUBTYPE=7 as specified in §2.2.3.2.7.3.2.

2.2.3.2.7.3 TYPE "23" ADS-B Messages for "TEST"

TYPE "23" ADS-B Messages **shall** be used for Test Purposes. "TEST" Messages **shall** be used exclusively for the broadcast of information in support of bench and/or certification testing of 1090 MHz ADS-B systems, or for the broadcast of information of interest only to local ADS-B ground applications. "TEST" Message broadcasts will not result in an ADS-B report being generated onboard any other ADS-B equipped aircraft, nor is the specific information being included in the "TEST" Message expected to be generally codified within internationally accepted standards. "TEST" Messages containing information of interest only to local ADS-B ground applications are intended to be used in support of technical or operational evaluations, or in support of local operational requirements.

These MOPS define two categories of use for the "TEST" Messages, SUBTYPE=0 and SUBTYPE=7. "TEST" Messages of SUBTYPEs 1 through 6 are reserved.

2.2.3.2.7.3.1 "TEST" Messages with SUBTYPE=0

"TEST" Messages with SUBTYPE=0 **shall** be used only for messages in support of bench and/or certification testing of 1090 MHz ADS-B systems. The format for "TEST" Messages with SUBTYPE=0 **shall** be shown in Figure 2-12.

"TEST" Message (TYPE=23 and SUBTYPE=0)			
MSG Bit #	33 ---------- 37	38 ---------- 40	41 ---------- 88
"ME" Bit #	1 ---------- 5	6 ---------- 8	9 ---------- 56
Field Name	**TYPE=23 [5]**	**SUBTYPE=0 [3]**	**Unformatted Test Data [48]**
	MSB LSB	MSB LSB	MSB LSB

Figure 2-12: "TEST" Message with SUBTYPE=0 Format

2.2.3.2.7.3.2 "TEST" Messages with SUBTYPE=7

Notes:

1. *The"TEST" Message with SUBTYPE=7 is provided as a transitional feature to aid operation of ground ATC automation systems that use the Mode A Code for Flight Plan correlation. The requirement for the use of this Subtype may be removed from future versions of these MOPS.*

2. *The "TEST" Message with SUBTYPE=7 is not applicable to Class B2 equipment.*

"TEST" Messages with SUBTYPE=7 **shall** be used for the broadcast of the Mode A, 4096, Code currently assigned to the aircraft. The format for "TEST" Messages with SUBTYPE=7 **shall** be as specified in Figure 2-13. The Mode A Code subfield **shall** be coded as defined in RTCA DO-181C, §2.2.13.1.2.b and §2.2.4.1.2. Starting with "ME" bit 9, the sequence **shall** be C1, A1, C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4.

"TEST" Messages with SUBTYPE=7 **shall not** be broadcast when the aircraft is in the "On-Ground" status (§2.2.3.2.1.2).

"TEST" Message (TYPE=23 and SUBTYPE=7)				
MSG Bit #	33 ---------- 37	38 ---------- 40	41 ----- 53	54 ---------- 88
"ME" Bit #	1 ---------- 5	6 ---------- 8	9 ----- 21	22 ---------- 56
Field Name	**TYPE=23 [5]**	**SUBTYPE=7 [3]**	**Mode A Code [13]**	**Reserved [35]**
	MSB LSB	MSB LSB	MSB LSB	MSB LSB

Figure 2-13: "TEST" Message with SUBTYPE=7 Format

2.2.3.2.7.3.2.1 "TEST" Message with SUBTYPE=7, Global Enable/Inhibit

Provision **shall** be made for a global parameter to control the transmission of the "TEST" Message with SUBTYPE=7. This parameter **shall** specify one of the following conditions:

a. Inhibit transmission of the "TEST" Message with SUBTYPE=7
b. Enable transmission of the "TEST" Message with SUBTYPE=7
c. Enable transmission of the "TEST" Message with SUBTYPE=7 with a geographic filter (§2.2.3.2.7.3.2.2)

For this version of these MOPS, the parameter **shall** be set as specified in subparagraph c, above.

2.2.3.2.7.3.2.2 "TEST" Message with SUBTYPE=7, Geographic Filter

Note: *Geographic filtering is used as a means to automatically enable or inhibit the broadcast of the "TEST" Message with SUBTYPE=7 which conveys the Mode A Code of the aircraft. The following paragraphs define the minimum level of geographic filtering necessary to satisfy this requirement. More sophisticated geographic filtering techniques may be used provided they can be demonstrated to enable the broadcast of "TEST" Messages with SUBTYPE=7 when the aircraft is operating within US airspace and inhibited when operating outside the general boundaries of North America (plus Hawaii).*

The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be enabled only if the geographic conditions specified in Table 2-77 are satisfied. The broadcast of "TEST" Messages with SUBTYPE=7 **shall** be inhibited if the current position is not available.

Table 2-77: "TEST" Messages with SUBTYPE=7, Geographic Filters

1	(Latitude-A1 $\leq$ $Lat_{current}$ $\leq$ Latitude-A2 (north positive), AND Longitude-A1 $\leq$ $Lon_{current}$ $\leq$ Longitude-A2 (east positive))
	OR
2	(Latitude-B1 $\leq$ $Lat_{current}$ $\leq$ Latitude-B2 (north positive), AND Longitude-B1 $\leq$ $Lon_{current}$ $\leq$ Longitude-B2 (east positive))
	OR
3	(Latitude-C1 $\leq$ $Lat_{current}$ $\leq$ Latitude-C2 (north positive), AND Longitude-C1 $\leq$ $Lon_{current}$ $\leq$ Longitude-C2 (east positive))

Where $Lat_{current}$ and $Lon_{current}$ define the current aircraft position.

Latitude and Longitude with a resolution of 0.1 degree or better **shall** be used for the purpose of determining whether the criteria specified in Table 2-77 are satisfied.

For this version of these MOPS:

Latitude-A1 = 18.0 degrees	Latitude-A2 = 75.0 degrees
Longitude-A1 = -170.0 degrees	Longitude-A2 = -65.0 degrees
Latitude-B1 = reserved	Latitude-B2 = reserved
Longitude-B1 = reserved	Longitude-B2 = reserved
Latitude-C1 = reserved	Latitude-C2 = reserved
Longitude-C1 = reserved	Longitude-C2 = reserved

Notes:

1. *Negative longitudes listed above are synonymous with west longitude.*

2. *Additional geographic areas may be used if desired to better define the specified operating area.*